of about 20 Å over the first sublayer. Alternatively, the first cap layer may be formed of a single layer of tantalum (Ta) having a thickness of 40 Å.

[0047] After the deposition of the central region **506** is completed, photoresist **602** is applied and exposed in a photolithography tool to mask SV sensor **500** in the central region **506** and then developed in a solvent to expose end regions **502** and **504**. The layers in the unmasked end regions **502** and **504** are removed by ion milling and end region layers **548** and **550** of alumina (Al_2O_3) are deposited in the end regions. Alternatively, longitudinal hard bias layers may be formed in the end regions **502** and **504** in order to provide a longitudinal bias field to the free layer **516** to ensure a single magnetic domain state in the free layer.

[0048] Photoresist **604** and photolithography processes are used to define the track width region **536** in the central region **506** of the SV sensor **500**. First and second leads L**1528** and L**2530** of rhodium (Rh) having a thickness in the range 200-600 Å are deposited over the end regions **502** and **504** and over the unmasked first cap layer **526** and in the first and second passive regions **532** and **534** which provide the desired lead/sensor overlap. After removal of the photoresist mask **604** in the track width region **536**, the leads L**1528** and L**2530** are used as masks for a sputter etch and reactive ion etch (RIE) process to remove the first cap layer **526** in the track width region **536**. After removal of the first cap layer, the exposed portions of the AFM layer **560** and the bias layer **522** in the track width region **536** are sputter etched with an oxygen containing gas to convert the AFM layer and ferromagnetic bias layers materials into a nonmagnetic oxide layer **538**. The second cap layer **540** of rhodium (Rh), or alternatively ruthenium (Ru), having a thickness of about 40 Å is deposited over the leads L**1528** and L**2530** in the end regions **502** and **504** and the passive regions **532** and **534** and over the nonmagnetic oxide layer **538** in the track field region **536**. After fabrication of the structure of the SV sensor **500** is completed, the AFM layer **560** is set so that the bias layer **522** is pinned in a longitudinal direction. To set the AFM layer **560**, the SV sensor **500** is heated to about 2650° C. in the presence of a magnetic field of about 13 kOe oriented in the longitudinal direction (that is, in the plane of the layers and parallel to the ABS) and held for about 5 hours. With the magnetic field still applied, the sensor is cooled before removing the magnetic field.

[0049] An alternative process for defining the AP-coupled antiparallel tabs in the passive regions may be used to replace the process of sputter etching with an oxygen containing gas to oxidize the AFM layer and ferromagnetic bias layer materials in the track width region. In the alternative process, the step of using a sputter etch and reactive ion etch (RIE) process to remove the first cap layer **526** in the track width region **536** is continued to also remove the AFM layer **560** and the bias layer **522** in the track width region. To protect the free layer **516** from the sputter etch and RIE process a secondary ion mass spectrometer (SIMS) installed in the vacuum chamber of the sputtering system is used to provide endpoint detection for the ruthenium (Ru) forming the spacer layer **523**. The second cap layer **540** of rhodium (Rh), or alternatively ruthenium (Ru), having a thickness of about 40 Å is deposited over the leads L**1528** and L**2530** in the end regions **502** and **504** and the passive regions **532** and **534** and over the spacer layer **523** in the track field region **536**.

SECOND EXAMPLE

[0050] **FIG. 7** depicts an air bearing surface (ABS) view, not to scale, of a lead overlay SV sensor **700** according to an alternative embodiment of the present invention. The SV sensor **700** differs from the SV sensor **500** of the first example in having the AFM layer **560** set so that the bias layer **522** is pinned in a transverse direction, or alternatively, in a canted direction oriented at an intermediate angle between the longitudinal and transverse directions. The layer structure and the method of making the SV sensor **700** is the same as described herein above with respect to the SV sensor **500** of the first example. Only the process of setting the AFM layer **560** so that the bias layer **522** is pinned in a transverse direction or a canted direction is different for the SV sensor **700**.

[0051] **FIG. 9** is plan view, not to scale, of a spin valve sensor **902** indicating the orientations of longitudinal, transverse and canted bias fields relative to an air bearing surface (ABS) **904**. The SV sensor has an approximately rectangular shape with front edge **906**, a back edge **908**, and two side edges **910**. The front edge is defined by the lapped ABS **904** which forms a plane perpendicular to the plane of the SV sensor layers. The back edge **908** is spaced away from the front edge **906** by a distance that defines the stripe height of the SV sensor. A longitudinal bias field has an orientation in the plane of the SV sensor layers and directed parallel to the ABS **904** and to the front edge **906** as indicated by the arrow **912** pointing to the right, or alternatively, in an opposite direction as indicated by the arrow **913** pointing to the left. A transverse bias field has an orientation in the plane of the SV sensor layers and directed perpendicular to the ABS **904** and to the front edge **906** as indicated by the arrow **914** pointing upward (away from the ABS), or alternatively, in an opposite direction as indicated by the arrow **915** pointing downward (toward the ABS). A canted bias field has an orientation in the plane of the SV sensor layers and directed at some angle θ to the plane of the ABS **904** intermediate between the directions of the longitudinal and transverse bias fields as indicated by the arrow **916**, or alternatively, in an opposite direction as indicated by arrow **917**. The angle θ may have any value between 0° and 180°.

[0052] After fabrication of the structure of the SV sensor **700** is completed, the AFM layer **560** is set so that the bias layer **522** is pinned in a transverse direction, or alternatively in a canted direction. To set the AFM layer **560**, the SV sensor **700** is heated to about 265° C. in the presence of a magnetic field of about 13 kOe oriented in the transverse direction (that is, in the plane of the layers and perpendicular to the ABS), or alternatively in a canted direction (that is, in the plane of the layers and at an angle θ with respect to the ABS) and held for about 5 hours. With the magnetic field still applied, the sensor is cooled before removing the magnetic field.

[0053] It should be understood that the antiparallel coupled tabs with AFM pinning in the lead/sensor overlap regions (passive regions **532** and **534**) of the present invention may be used with any bottom spin valve sensor (SV) (sensor having the pinned layers located near the bottom of the stacked layers). In the bottom spin valve structure, the free layer can be easily AP-coupled to a bias layer and oxidation of the ferromagnetic bias layer to form a nonmagnetic oxide in the track width region can be easily accom-